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SAMSUNG TFT-LCD PRODUCT INFORMATION

MODEL : LTM185AT01

Note : This is Product Information is subject to change after 3 months of issuing date.

Application Engineering Part 1, HD LCD Division

Samsung Electronics Co . , LTD.



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General Description

Description

LTM185AT01 product is a color active matrix liquid crystal display (LCD) that uses amorphous silicon TFT (Thin Film Transistor) as switching components. This model is composed of a TFT LCD panel, a driver circuit and a back light unit. The resolution of a 18.5" is 1366 X 768 and this model can display up to 16.7 millions colors.

Features

- High contrast ratio, high aperture structure
- TN (Twisted Nematic) mode
- Wide Viewing Angle
- High speed response
- HD (1366 x 768 pixels) resolution
- Low power consumption
- 2 CCFLs (Cold Cathode Fluorescent Lamp)
- DE (Data Enable) only mode
- LVDS (Low Voltage Differential Signaling) interface (1pixel/clock)
- Compact Size Design
- RoHS compliance
- TCO'03 compliance

Applications

- Workstation & desktop monitors
- Display terminals for AV application products
- Monitors for industrial machine

* If the module is used to other applications besides the above, please contact SEC in advance.

General Information

Items	Specification	Unit	Note
Pixel Pitch	0.300(H) x 0.300(W)	mm	
Active Display Area	409.8(H) x 230.4(V)	mm	
Surface Treatment	Haze 25%, Hard-coating(3H)		
Display Colors	16.7M (6bit Hi-FRC)	colors	
Number of Pixels	1366 x 768	pixel	
Pixel Arrangement	RGB vertical stripe		
Display Mode	Normally White		
Luminance of White	250(Typ.)	cd/m ²	

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Mechanical Information

Item		Min.	Typ.	Max.	Unit	Note
Module size	Horizontal (H)	429.87	430.37	430.87	mm	w/o inverter ass'y
	Vertical (V)	254.1	254.6	255.1	mm	
	Depth (D)	-	-	17.0	mm	
Weight		-	-	2,100	g	LCD module only

Note (1) Mechanical tolerance is $\pm 0.5\text{mm}$ unless there is a special comment.

1. Absolute Maximum Ratings

If the condition exceeds maximum ratings, it can cause malfunction or unrecoverable damage to the device.

Item	Symbol	Min.	Max.	Unit	Note
Power Supply Voltage	V_{DD}	GND-0.5	6.5	V	(1)
Storage temperature	T_{STG}	-25	60	°C	(2)
Glass surface temperature (Operation)	T_{OPR}	0	50	°C	(2)
Shock (non - operating)	S_{nop}	-	50	G	(3)
Vibration (non - operating)	V_{nop}	-	1.5	G	(4)

Note (1) $T_a = 25 \pm 2^\circ\text{C}$

- (2) Temperature and relative humidity range are shown in the figure below.
- 90 % RH Max. ($T_a \leq 39^\circ\text{C}$)
 - Maximum wet-bulb temperature at 39°C or less. ($T_a \leq 39^\circ\text{C}$)
 - No condensation
- (3) 11ms, sine wave, one time for $\pm X$, $\pm Y$, $\pm Z$ axis
- (4) 10-300 Hz, Sweep rate 10min, 30min for X,Y,Z axis

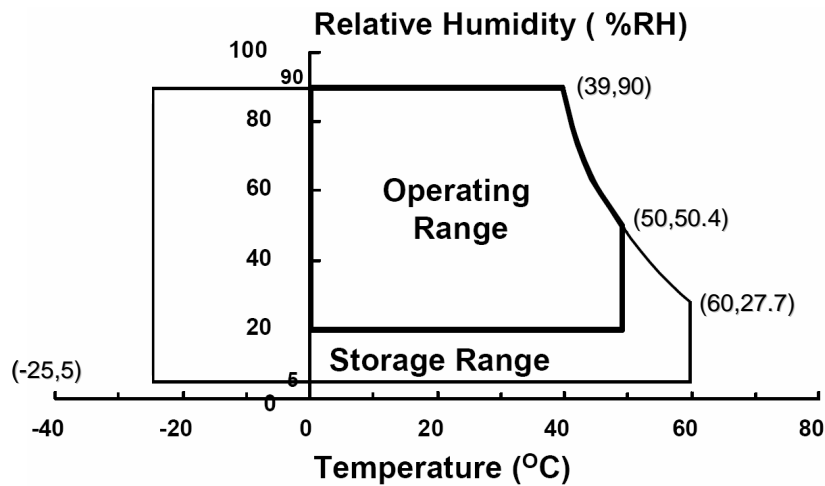


Fig. Temperature and Relative humidity range

2. Optical Characteristics

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The optical characteristics should be measured in a dark room or equivalent.

Measuring equipment : SR-3, RD-80S (TOPCON), EZ-Contrast (Eldim)

(Ta = 25 ± 2°C, VDD=5V, fv= 60Hz, fDCLK=85.8MHz, IL = 7.5mArms)

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Note
Contrast Ratio (Center of screen)		C/R		600	1000	-		(3) SR-3
Response Time	On/Off	Tr+ Tf		-	5	10	msec	(5) RD-850S
Luminance of White (Center of screen)		Y _L		200	250	-	cd/m2	(6) SR-3
Color Chromaticity (CIE 1931)	Red	Rx	Normal θ _{L,R} =0 θ _{U,D} =0 Viewing Angle	-0.030	0.645	+0.030		
		Ry			0.335			
	Green	Gx			0.290			
		Gy			0.605			
	Blue	Bx			0.150			
		By			0.075			
	White	Wx			0.313			
		Wy			0.329			(7),(8)
	Red	Ru'		-	0.450	-		SR-3
		Rv'		-	0.526	-		
Color Chromaticity (CIE 1976)	Green	Gu'		-	0.120	-		
		Gv'		-	0.563	-		
	Blue	Bu'		-	0.167	-		
		Bv'		-	0.188	-		
	White	Wu'		-	0.198	-		
		Wv'		-	0.468	-		
	White	Wu'		-	0.198	-		
		Wv'		-	0.468	-		
C.G.L	White	Δu'v'		-	0.011	0.02		(9)

* C.G.L : Color Grayscale Linearity

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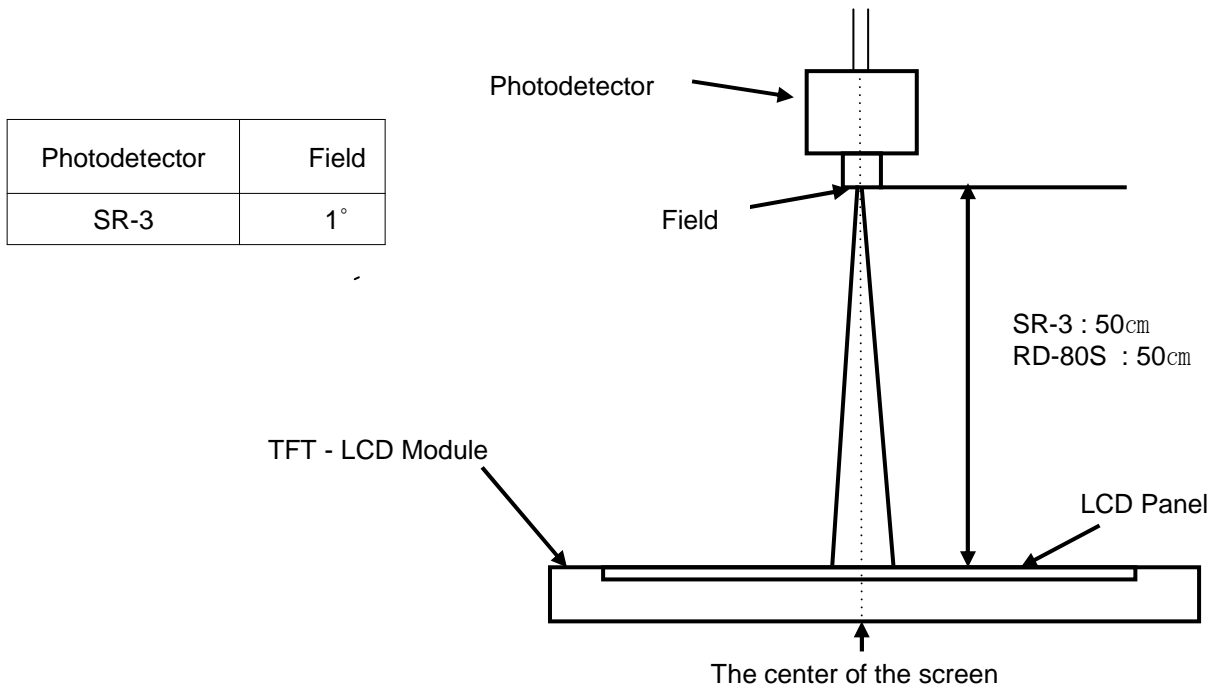
Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Note
Color Gamut	-		-	72 (84)	-	%	CIE1931 (CIE1976)
Color Temperature	-		-	6500	-	K	
Viewing Angle	Hor.	θ_L	$CR \geq 10$	70	80	-	Degrees (8) EZ-Contrast
		θ_R		70	80	-	
	Ver.	θ_U		70	80	-	
		θ_D		70	80	-	
Brightness Uniformity (9 Points)	B_{uni}		-	-	25	%	(4) SR-3

Note (1) Test Equipment Setup

The measurement should be executed in a stable, windless and dark room between 30min after lighting the back light at the given temperature for stabilization of the back light. This should be measured in the center of screen.

Single lamp current : 7.5mA

Environment condition : $T_a = 25 \pm 2^\circ\text{C}$



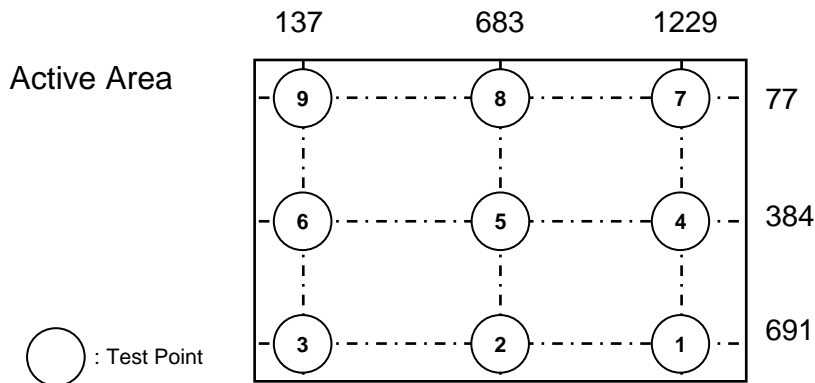
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Note (2) Definition of test point



Note (3) Definition of Contrast Ratio (C/R)

: Ratio of gray max (Gmax) & gray min (Gmin) at the center point⑤ of the panel

$$CR = \frac{G \max}{G \min}$$

Gmax : Luminance with all pixels white

Gmin : Luminance with all pixels black

Note (4) Definition of 9 points brightness uniformity

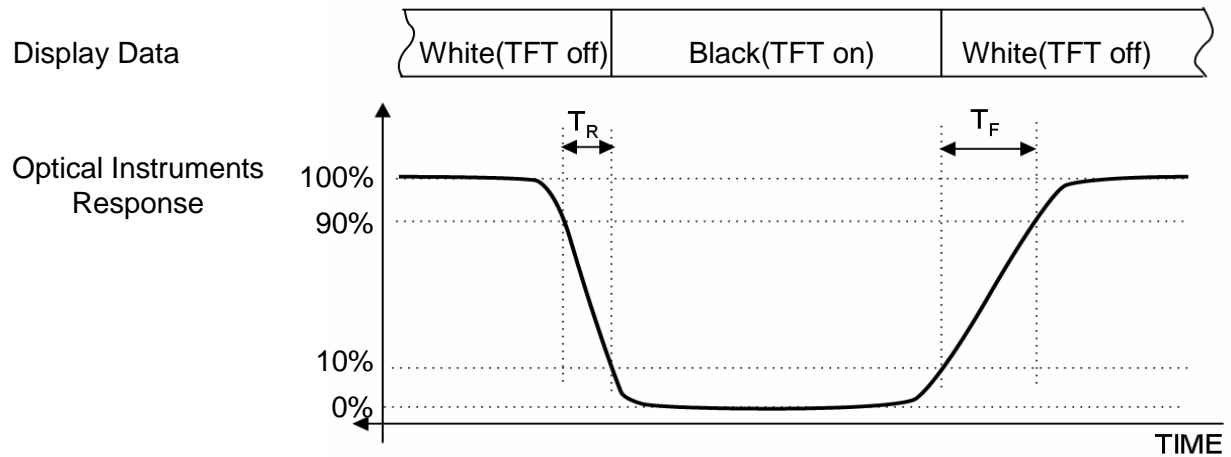
$$Buni = 100 \times \frac{(B \max - B \min)}{B \max}$$

Bmax : Maximum brightness

Bmin : Minimum brightness

Note (5) Definition of Response time

a. On/Off response time : Sum of T_R , T_F



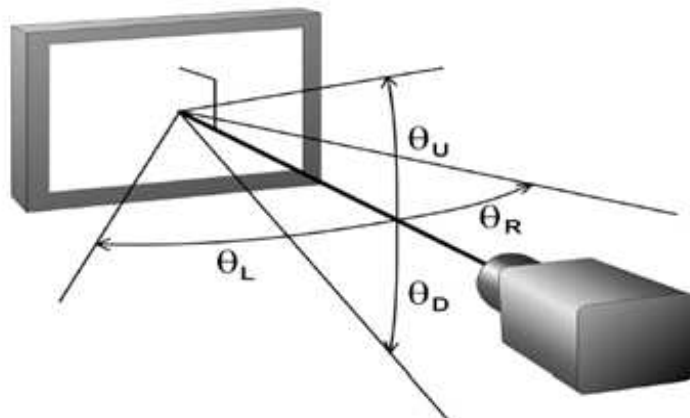
Note (6) Definition of Luminance of White : Luminance of white at center point⑤

Note (7) Definition of Color Chromaticity (CIE 1931, CIE1976)

Color coordinate of Red, Green, Blue & White at center point⑤

Note (8) Definition of Viewing Angle

: Viewing angle range ($CR \geq 10$)



Note (9) Color Grayscale Linearity

- a. Test image : 100% full white pattern with a test pattern as below
- b. Test pattern : Squares, 40mm by 40mm in size, filled with 255, 225, 195, 165, 135 and 105 grays steps should be arranged at the center⑤ of the screen.



c. Test method

- 1st gray step : move a square of 255 gray level should be moved into the center of the screen and measure luminance and u' and v' coordinates.
- Next gray step : Move a 225 gray square into the center and measure both luminance and coordinates, too.

d. Test evaluation

$$\Delta u'v' = \sqrt{(u'_A - u'_B)^2 + (v'_A - v'_B)^2}$$

Where A, B : 2 gray levels found to have the largest color differences between them
i.e. get the largest $\Delta u'$ and $\Delta v'$ of each 6 pair of u' and v' and calculate the $\Delta u'v'$.

3. Electrical Characteristics

3.1 TFT LCD Module

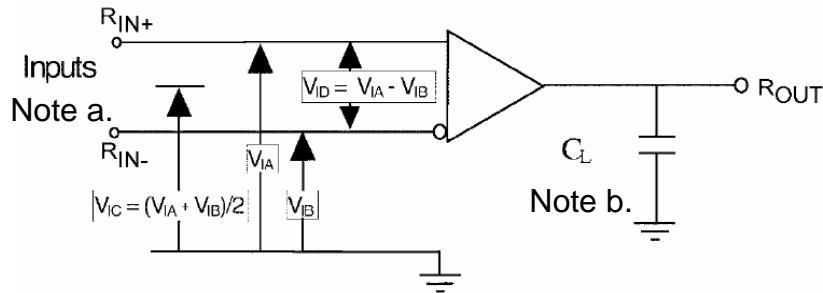
The connector for display data & timing signal should be connected.

Ta = 25°C

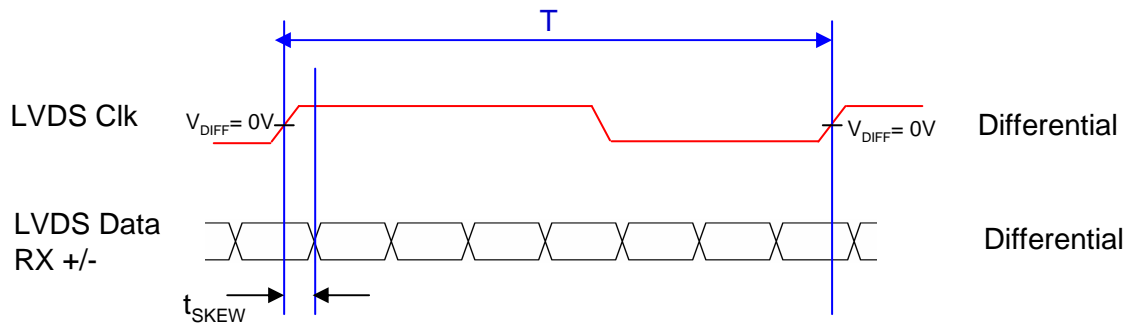
Item		Symbol	Min.	Typ.	Max.	Unit	Note
Voltage of Power Supply		V_{DD}	4.5	5.0	5.5	V	(1)
LVDS Input Characteristics	Differential Input Voltage for LVDS Receiver Threshold	High	-	-	+100	mV	(2)
		Low	-100	-	-	mV	
	LVDS skew	t_{SKEW}	-300		300		(3)
	Differential input voltage	$ V_{ID} $	200		600	mV	(4)
	Input voltage range (single-ended)	V_{IN}	0		2.4	V	(4)
	Common mode voltage	V_{CM}	0+ $ V_{ID} /2$	1.2	2.4- $ V_{ID} /2$	V	(4)
Current of Power Supply	(a) Black	I_{DD}	-	550	-	mA	(5),(6)
	(b) White		-	400	-	mA	
	(c) Dot		-	700	1000	mA	
Vsync Frequency		f_V	47	60	75	Hz	
Hsync Frequency		f_H	37.13	47.40	59.25	kHz	
Main Frequency		f_{DCLK}	56.66	72.33	90.42	MHz	
Rush Current		I_{RUSH}	-	-	3	A	(7)

Note (1) The ripple voltage should be controlled under 10% of V_{DD} .

- (2) Differential receiver voltage definitions and propagation delay and transition time test circuit
- All input pulses have frequency = 10MHz, t_R or $t_F=1\text{ns}$
 - C_L includes all probe and fixture capacitance



- (3) LVDS Receiver DC parameters are measured under static and steady conditions which may not be reflective of its performance in the end application.

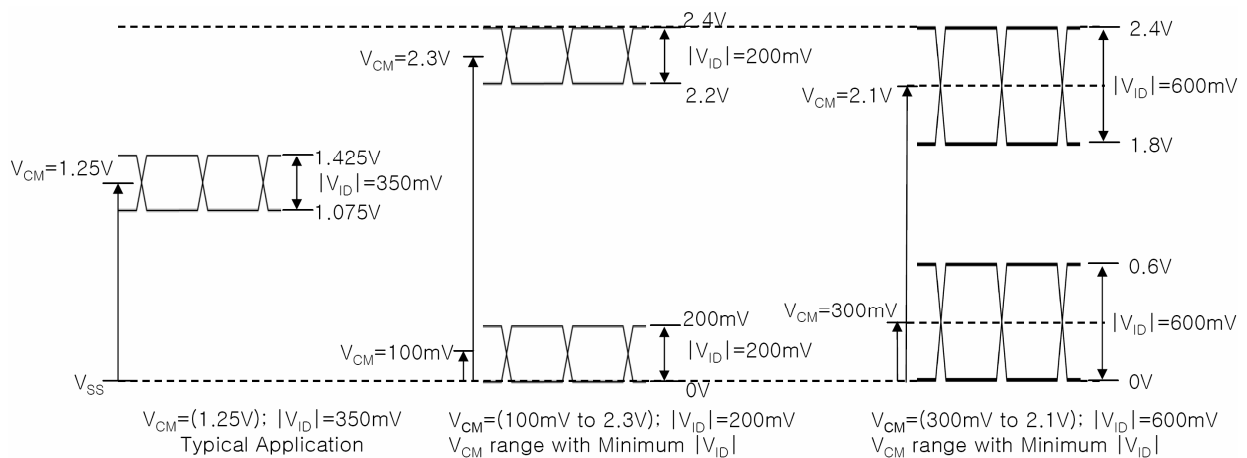


where t_{skew} : skew between LVDS clock & LVDS data,

T : 1 period time of LVDS clock

cf) (-/+) of 300psec means LVDS data goes before or after LVDS clock.

- (4) Definition of V_{ID} and V_{CM} using single-end signals



(5) $f_V=60\text{Hz}$, $f_{\text{DCLK}} = 85.8\text{MHz}$, $V_{\text{DD}} = 5.0\text{V}$, DC Current.

(6) Power dissipation check pattern (LCD Module only)

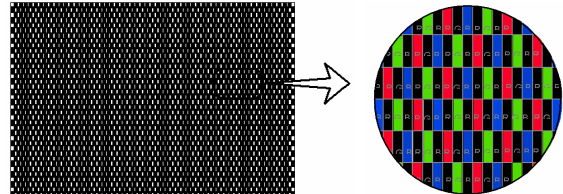
a) Black Pattern



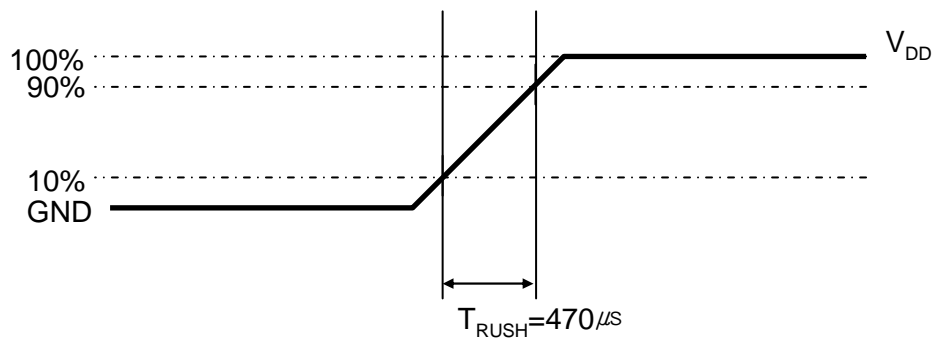
b) White Pattern



c) Dot Pattern



(7) Measurement Condition



Rush Current I_{RUSH} can be measured when T_{RUSH} is $470 \mu\text{s}$.

3.2 Back Light Unit

The back light unit is an edge type with 2 CCFLs(Cold Cathode Fluorescent Lamp).
The characteristics of those lamps are shown in the following table.

$T_a = 25 \pm 2^\circ\text{C}$

Item		Symbol	Min.	Typ.	Max.	Unit	Note
Lamp Current		I _L	3.0	7.5	8.0	mArms	(1)
Lamp Voltage		V _L	-	700	-	Vrms	
Lamp Frequency		f _L	45	-	60	kHz	(2)
Operating Life Time		Hr	50,000	-	-	Hour	(3)
Inverter waveform	Asymmetry rate	Wasy	-	-	10	%	(4)
	Distortion rate	Wdis	1.2726	1.414	1.5554		
Startup Voltage		Vs	-	-	0℃ : 1,480	Vrms	(5)
					25℃: 1,170		

Note (1) Specified values are for a single lamp.

Lamp current is measured with current meter for high frequency as shown below.

Refer to the following block diagram of the back light unit for more information.

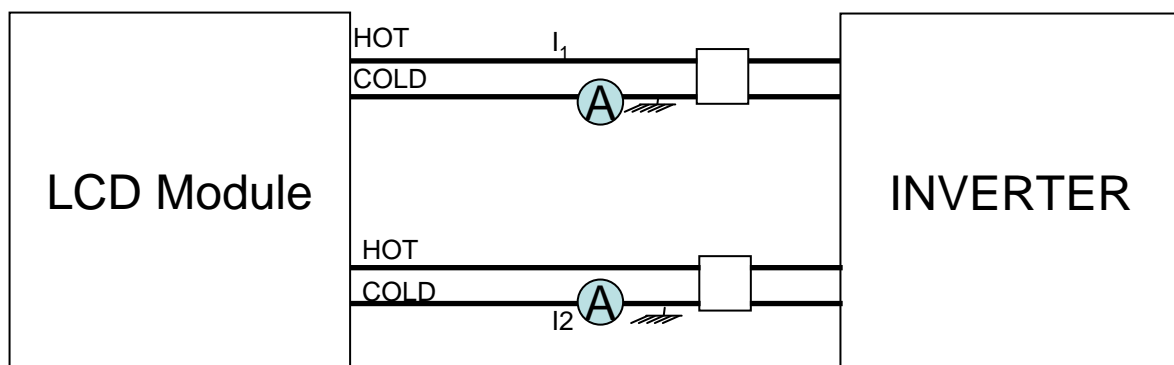


Fig. Measurement point of Lamp Current

(2) Lamp frequency which may produce interference with horizontal synchronous frequency may cause line flow on the display. Therefore lamp frequency should be detached from the horizontal synchronous frequency and its harmonics as far as possible in order to avoid interference.

(3) Life time (Hr) is defined as the time when brightness of a lamp unit itself becomes 50% or less than its original value at the condition of $T_a = 25 \pm 2^\circ\text{C}$ and $I_L = 7.5\text{mA}_{\text{rms}}$

(4) Designing a system inverter intended to have better display performance, power efficiency and lamp reliability.

They would help increase the lamp lifetime and reduce leakage current.

- The measurement should be done at typical lamp current.
- The asymmetry rate of the inverter waveform should be less than 10%.
- The distortion rate of the waveform should be $\sqrt{2}$ with $\pm 10\%$ tolerance.
 - Inverter output waveform had better be more similar to ideal sine wave.

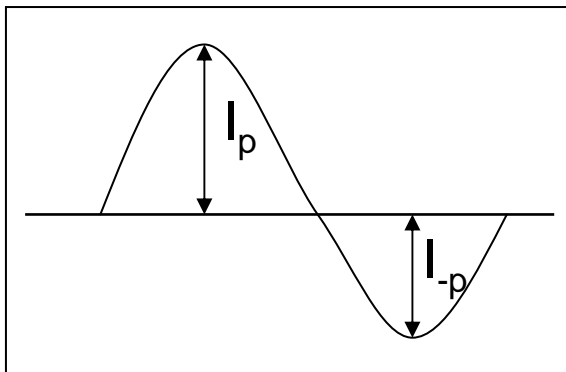


Fig. Wave form of the inverter

- Asymmetry rate

$$\frac{|I_p - I_{-p}|}{I_{rms}} \times 100$$

- Distortion rate

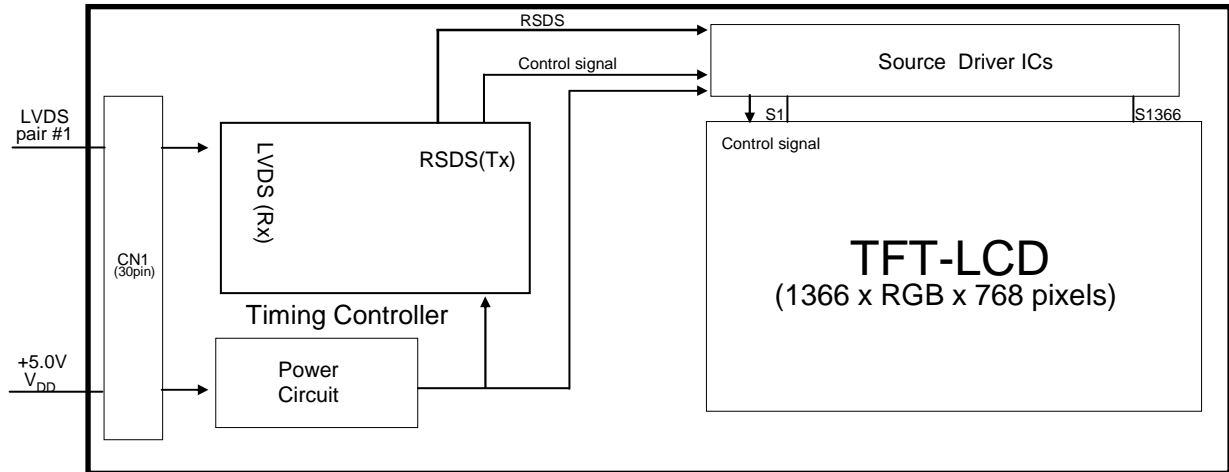
$$\left| \frac{I_p}{I_{rms}} \right| \text{ or } \left| \frac{I_{-p}}{I_{rms}} \right|$$

(5) If an inverter has shutdown function, it should keep its output for over 1 second even if the lamp connector is open. Otherwise the lamps may not be turned on.

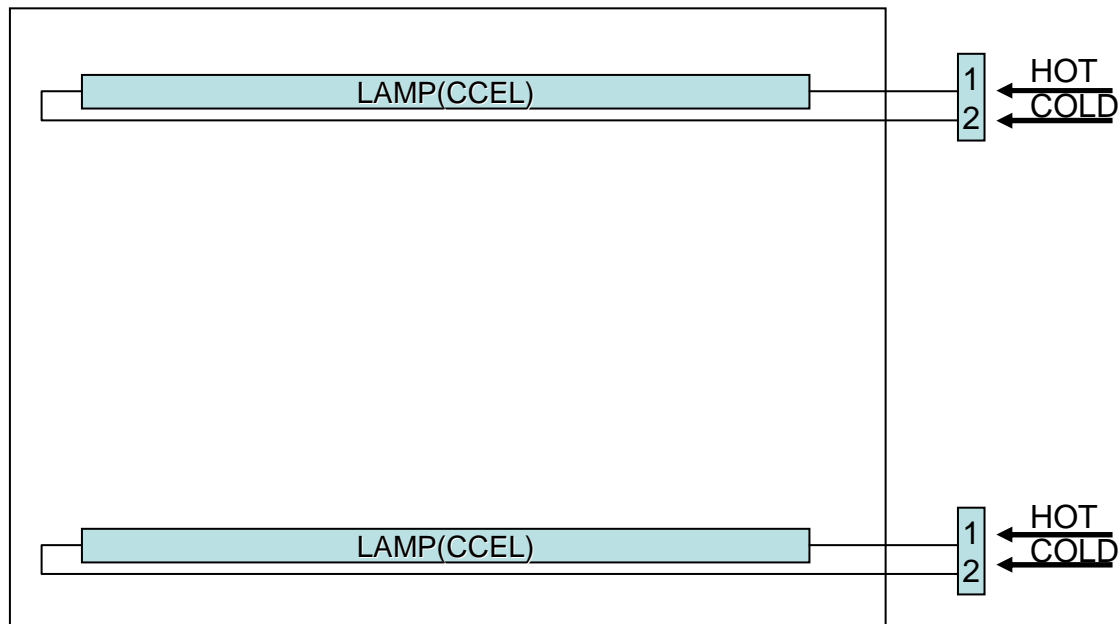
4. BLOCK DIAGRAM

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4.1 TFT LCD Module



4.2 Back Light Unit



5. Input Terminal Pin Assignment

5.1. Input Signal & Power (Connector : UJU IS100-L30O-C23 or equivalent)

PIN NO	SYMBOL	FUNCTION
1	CTL	No Connection (for DVR : CTL)
2	CE	No Connection (for DVR : CE)
3	NC	No Connection
4	GND	Power Ground
5	RXIN0-	Negative LVDS Differential Data Input (0)
6	RXIN0+	Positive LVDS Differential Data Input (0)
7	GND	Power Ground
8	RXIN1-	Negative LVDS Differential Data Input (1)
9	RXIN1+	Positive LVDS Differential Data Input (1)
10	GND	Power Ground
11	RXIN2-	Negative LVDS Differential Data Input (2)
12	RXIN2+	Positive LVDS Differential Data Input (2)
13	GND	Power Ground
14	RXCLKIN-	Negative LVDS Differential Clock Input (Clock)
15	RXCLKIN+	Positive LVDS Differential Clock Input (Clock)
16	GND	Power Ground
17	RXIN3-	Negative LVDS Differential Data Input (3)
18	RXIN3+	Positive LVDS Differential Data Input (3)
19	GND	Power Ground
20	NC	No Connection
21	NC	No Connection
22	NC	No Connection
23	GND	Power Ground
24	GND	Power Ground
25	GND	Power Ground
26	VCC	Power Supply : +5V
27	VCC	
28	VCC	
29	VCC	
30	VCC	

* If the system already uses the 1, 2pins, it should keep under GND level
The voltage applied to those pins should not exceed -200mV.

Note) Pin number starts from Left side

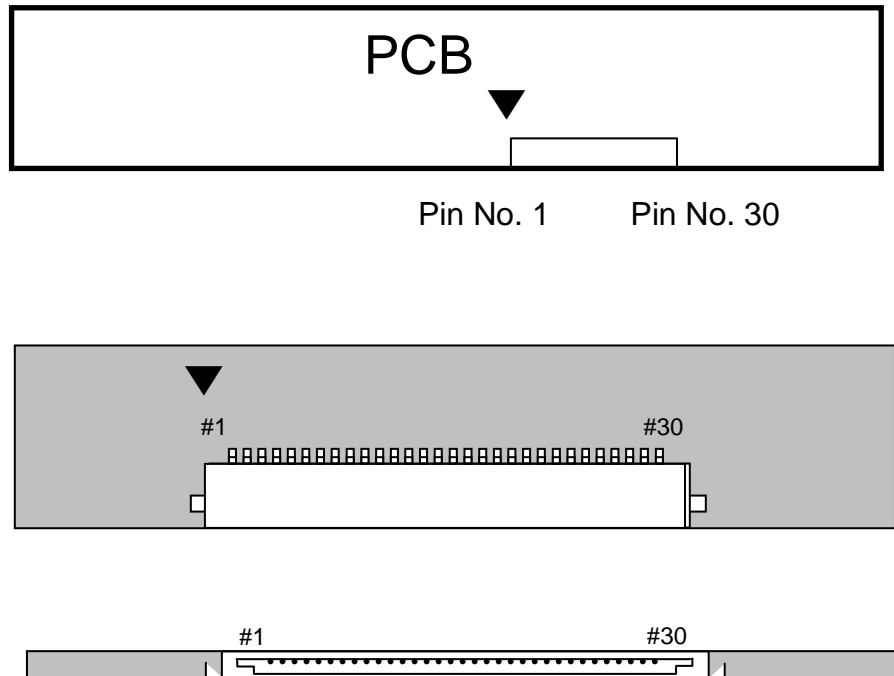
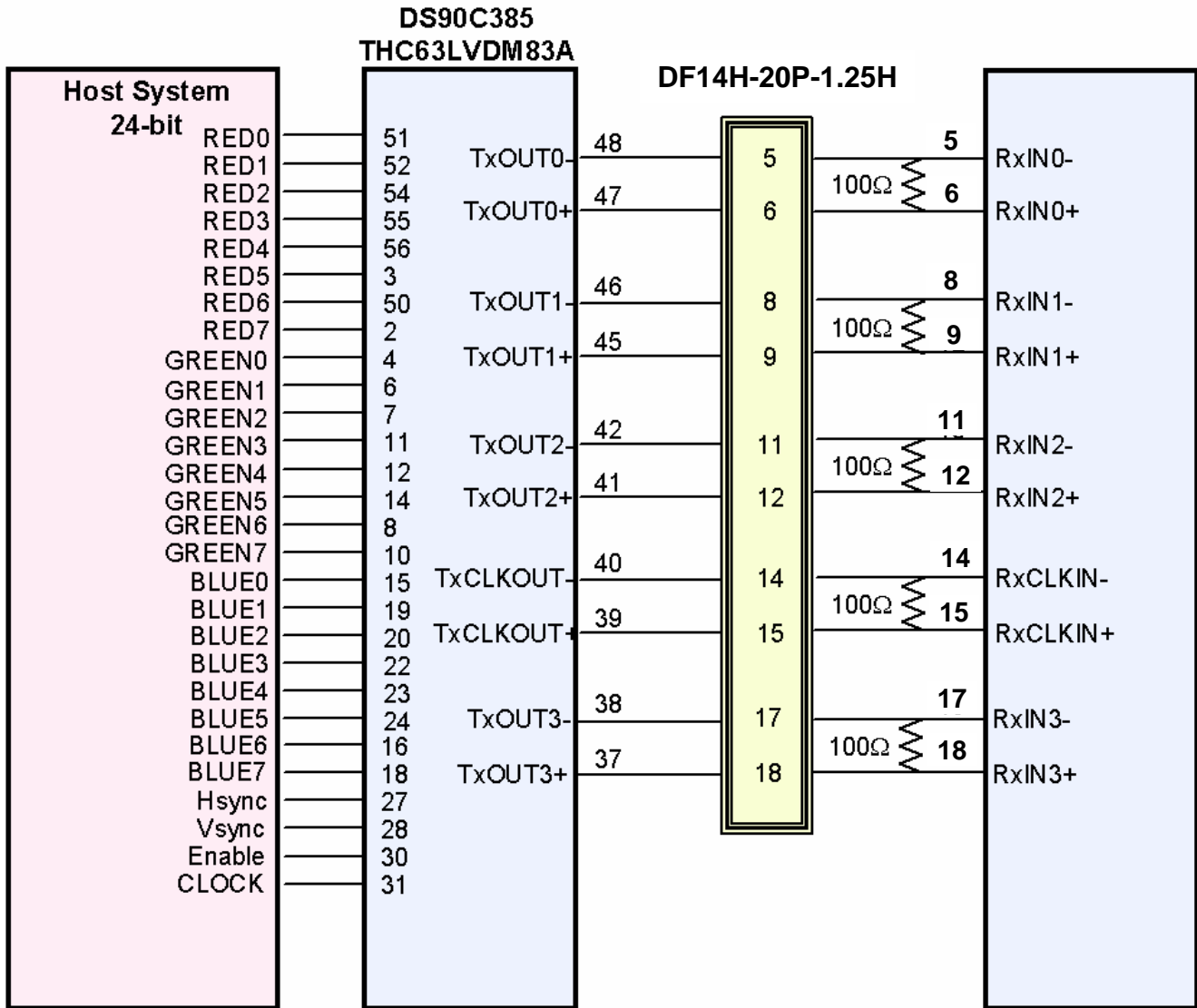


Fig. Connector diagram

- All GND pins should be connected together and also be connected to the LCD's metal chassis.
- All power input pins should be connected together.
- All NC pins should be separated from other signal or power.

5.2 LVDS Interface

5.2.1 Pixel data

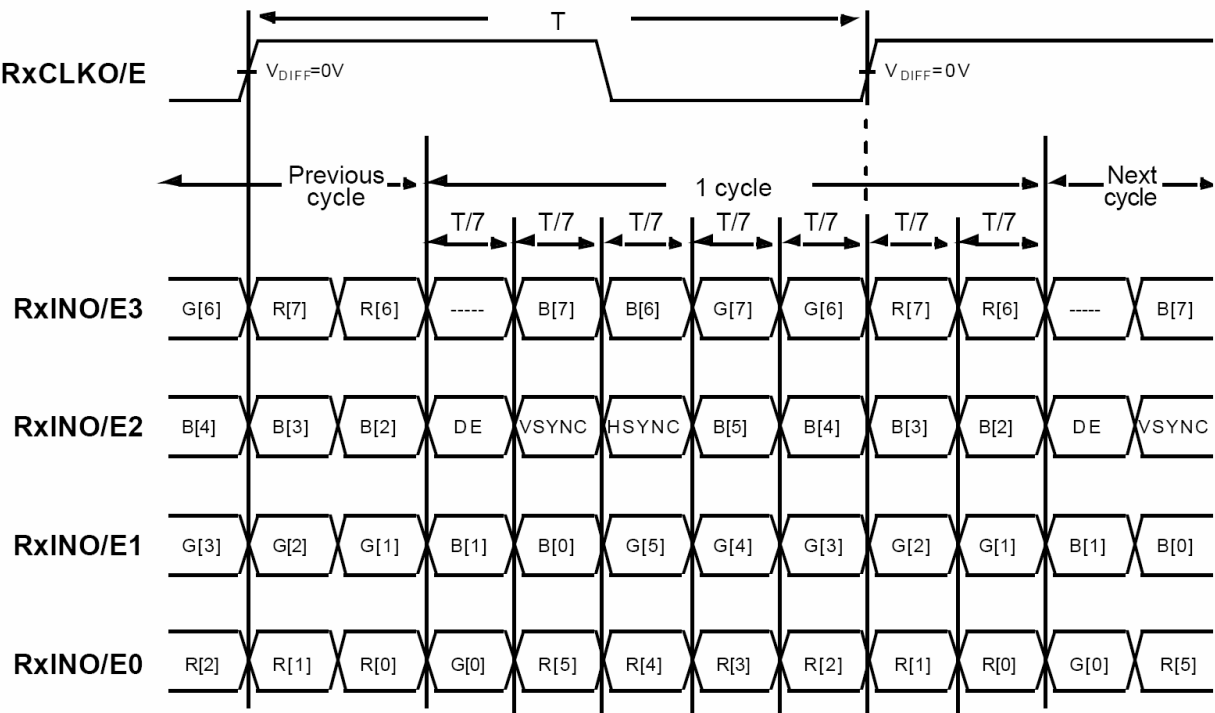


Note :

The LCD Module uses a 100ohm resistor between positive and negative lines of each receiver input.

5.2.2 Timing Diagrams of LVDS For Transmitting

LVDS Receiver : Integrated T-CON



5.3 Back Light Unit

	Pin No.	Input	Color	Function
Upper	1	Hot – 1	Red	High Voltage
	2	Cold – 1	White	Ground
Lower	1	Hot – 1	Red	High Voltage
	2	Cold – 1	White	Ground
	Connect or Part No.	Yeonho 35001HS-02L or equivalent		

5.4 Input Signals, Basic Display Colors and Gray Scale of Each Color

COLOR	DISPLAY (8bit)	DATA SIGNAL																												GRAY SCALE LEVEL
		RED									GREEN								BLUE											
		R0	R1	R2	R3	R4	R5	R6	R7	G0	G 1	G 2	G3	G 4	G 5	G6	G 7	B0	B1	B2	B3	B4	B5	B6	B7					
BASIC COLOR	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-		
	BLUE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	-			
	GREEN	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	-			
	CYAN	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-			
	RED	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-			
	MAGENT A	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	-			
	YELLOW	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	-			
	WHITE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	-			
GRAY SCALE OF RED	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R0			
	DARK ↑	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R1			
		0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R2			
		:	:	:	:	:	:			:	:	:	:	:	:			:	:	:	:	:	:			R3~ R252				
		:	:	:	:	:	:			:	:	:	:	:	:			:	:	:	:	:	:							
	↓ LIGHT	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R253			
		0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R254			
	RED	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R255			
GRAY SCALE OF GREEN	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	G0			
	DARK ↑	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	G1			
		0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	G2			
		:	:	:	:	:	:			:	:	:	:	:	:			:	:	:	:	:	:			G3~ G252				
		:	:	:	:	:	:			:	:	:	:	:	:			:	:	:	:	:	:							
	↓ LIGHT	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	G253			
		0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	G254			
	GREEN	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	G255			
GRAY SCALE OF BLUE	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	B0			
	DARK ↑	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	B1			
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	B2			
		:	:	:	:	:	:			:	:	:	:	:	:			:	:	:	:	:	:			B3~ B252				
		:	:	:	:	:	:			:	:	:	:	:	:			:	:	:	:	:	:							
	↓ LIGHT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	1	B253			
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	B254			
	BLUE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	B255			

Note (1) Definition of Gray :

Rn : Red Gray, Gn : Green Gray, Bn : Blue Gray (n = Gray level)

Input Signal : 0 = Low level voltage, 1 = High level voltage

6. Interface Timing

6.1 Timing Parameters (DE only mode)

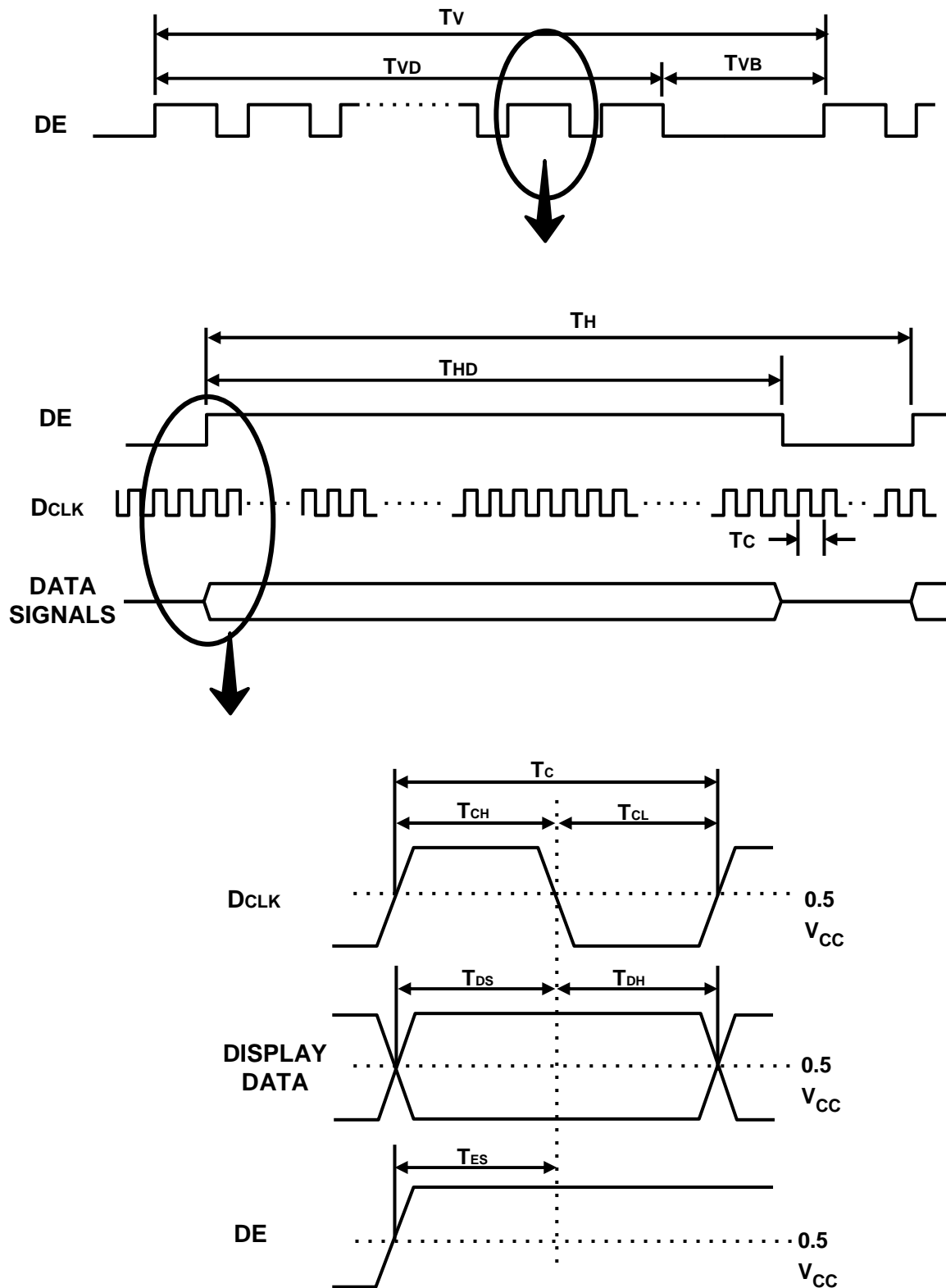
SIGNAL	ITEM	SYMBOL	MIN.	TYP.	MAX.	Unit	NOTE
Clock	Frequency	$1/T_C$	56.66	72.33	90.42	MHz	-
Hsync		F_H	37.13	47.40	59.25	KHz	-
Vsync		F_V	47	60	75	Hz	-
Vertical Display Term	Active Display Period	T_{VD}	768	768	768	Lines	-
	Vertical Total	T_{VB}	776	790	948	lines	-
Horizontal Display Term	Active Display Period	T_{HD}	1366	1366	1366	Clocks	-
	Horizontal Total	T_H	1446	1526	1830	clocks	-

Note (1) This product is DE only mode. The input of Hsync & Vsync signal does not have an effect on normal operation.

(2) Test Point : TTL control signal and CLK at LVDS Tx input terminal in system

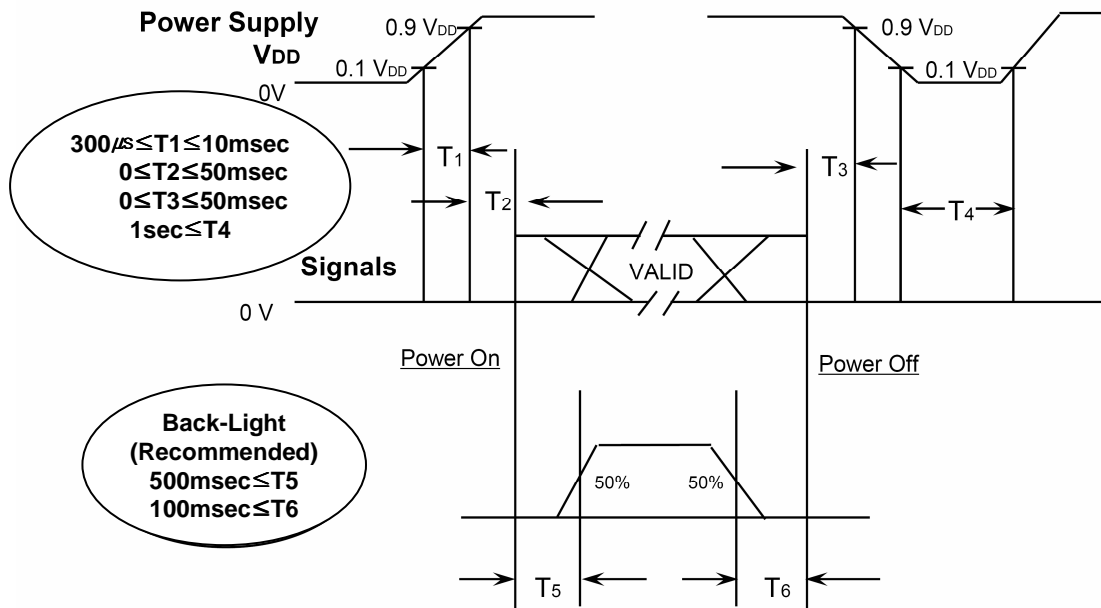
(3) Internal Vcc = 3.3V

6.2 Timing diagrams of interface signal (DE only mode)



6.3 Power ON/OFF Sequence

To prevent a latch-up or DC operation of the LCD Module, the power on/off sequence should be as the diagram below.



T1 : V_{DD} rising time from 10% to 90%

T2 : The time from V_{DD} to valid data at power ON.

T3 : The time from valid data off to V_{DD} off at power Off.

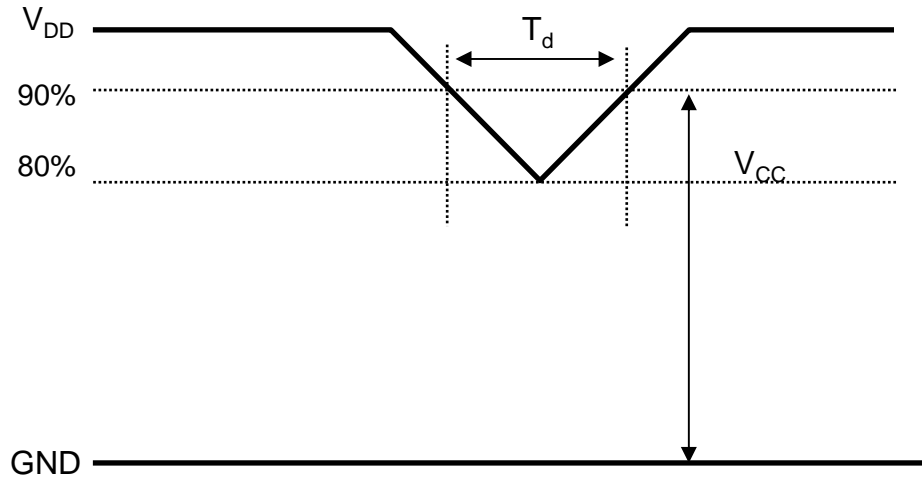
T4 : V_{DD} off time for Windows restart

T5 : The time from valid data to B/L enable at power ON.

T6 : The time from valid data off to B/L disable at power Off.

- The supply voltage of the external system for the Module input should be the same as the definition of V_{DD}.
- Apply the lamp voltage within the LCD operation range. When the back light turns on before the LCD operation or the LCD turns off before the back light turns off, the display may momentarily show abnormal screen.
- In case of V_{DD} = off level, please keep the level of input signals low or keep a high impedance.
- T4 should be measured after the Module has been fully discharged between power off and on period.
- Interface signal should not be kept at high impedance when the power is on.

6.4 VDD Power Dip Condition



$$4.5V \leq V_{DD} \leq 5.5V$$

$$\text{If } V_{DD}(\text{typ.}) \times 80\% \leq V_{CC} \leq V_{DD}(\text{typ.}) \times 90\%, \text{ then } 0 < T_d \leq 20\text{msec}$$

- Note (1) The above conditions are for the glitch of the input voltage.
- (2) For stable operation of an LCD Module power, please follow them.
i.e., if $\text{typ VDD} \times 80\% \leq V_{CC} \leq \text{typ VDD} \times 90\%$, then T_d should be less than 20ms.

7. Outline Dimension

[Refer to the next page]

8. General Precautions

PRODUCT INFORMATION

8.1 Handling

- (a) When the module is assembled, it should be attached to the system firmly using all mounting holes. Be careful not to twist and bend the module.
- (b) Because the inverter uses high voltages, it should be disconnected from power source before it is assembled or disassembled.
- (c) Refrain from strong mechanical shock and / or any force to the module.
In addition to damage, it may cause improper operation or damage to the module and CCFT back light.
- (d) Note that polarizer films are very fragile and could be damaged easily.
Do not press or scratch the surface harder than a HB pencil lead.
- (e) Wipe off water droplets or oil immediately. If you leave the droplets for a long time, staining or discoloration may occur.
- (f) If the surface of the polarizer is dirty, clean it using absorbent cotton or soft cloth.
- (g) Desirable cleaners are water, IPA (Isopropyl Alcohol) or Hexane.
Do not use Ketone type materials (ex. Acetone), Ethyl alcohol, Toluene, Ethyl acid or Methyl chloride. It might cause permanent damage to the polarizer due to chemical reaction.
- (h) If the liquid crystal material leaks from the panel, it should be kept away from the eyes or mouth . In case of contact with hands, legs or clothes, it must be washed away with soap thoroughly.
- (i) Protect the Module from static, or the CMOS Gate Array IC would be damaged.
- (j) Use finger-stalls with soft gloves in order to keep display clean during the incoming inspection and assembly process.
- (k) Do not disassemble the Module.
- (l) Do not pull or fold the lamp wire.
- (m) Do not adjust the variable resistor located on the Module.
- (n) Protection film for polarizer on the Module should be slowly peeled off just before use so that the electrostatic charge can be minimized.
- (o) Pins of I/F connector should not be touched directly with bare hands.

8.2 Storage

- (a) Do not leave the Module in high temperature, and high humidity for a long time. It is highly recommended to store the Module with temperature from 0 to 35 °C and relative humidity of less than 70%.
- (b) Do not store the TFT-LCD Module in direct sunlight.
- (c) The Module should be stored in a dark place. It is prohibited to apply sunlight or fluorescent light in storing.

8.3 Operation

- (a) Do not connect or disconnect the Module in the "Power On" condition.
- (b) Power supply should always be turned on/off by the item 6.3 "Power on/off sequence"
- (c) Module has high frequency circuits. Sufficient suppression to the electromagnetic interference should be done by system manufacturers. Grounding and shielding methods may be important to minimize the interference.
- (d) The cable between the back light connector and its inverter power supply should be connected directly with a minimized length. A longer cable between the back light and the inverter may cause lower luminance of lamp(CCFT) and may require higher startup voltage(Vs).

8.4 Operation Condition Guide

- (a) The LCD product should be operated under normal conditions.
Normal condition is defined as below;
 - Temperature : $20 \pm 15^{\circ}\text{C}$
 - Humidity : $65 \pm 20\%$
 - Display pattern : continually changing pattern (Not stationary)
- (b) If the product will be used in extreme conditions such as high temperature, humidity, display patterns or operation time etc., It is strongly recommended to contact SEC for Application engineering advice. Otherwise, its reliability and function may not be guaranteed. Extreme conditions are commonly found at Airports, Transit Stations, Banks, Stock market, and Controlling systems.

8.5 Others

- (a) Ultra-violet ray filter is necessary for outdoor operation.
- (b) Avoid condensation of water. It may result in improper operation or disconnection of electrode.
- (c) Do not exceed the absolute maximum rating value. (supply voltage variation, input voltage variation, variation in part contents and environmental temperature, and so on)
Otherwise the Module may be damaged.
- (d) If the Module keeps displaying the same pattern for a long period of time, the image may be "stuck" to the screen.
To avoid image sticking, it is recommended to use a screen saver.
- (e) This Module has its circuitry PCB's on the rear side and should be handled carefully in order not to be stressed.
- (f) Please contact SEC in advance when you display the same pattern for a long time.